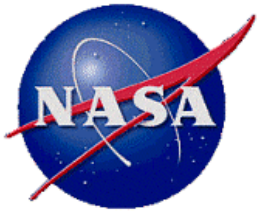

WHITE PAPER

Linking Acquisition Strategy to Contract Performance over the Product Life Cycle

Submitted to the NASA Exploration Enterprise (Code T)

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Product acquisition and sustainment have traditionally been separate and not necessarily equal concerns. The government's primary focus has been on the acquisition of technology and systems. Typically secondary concerns are sustainment once the system was procured, technology transfer and development of industrial base to support systems long term. The changing playing field for government acquisition has resulted in consequences for major programs that span years if not decades. As NASA embarks on the Exploration Initiative, it would be wise to learn from the past decade of acquisition reform, Space Shuttle contracts and NASA experience with Performance Based Contracts and Spiral Development. The ultimate goal in an acquisition strategy is to build the partnership relationships that align goals for the duration of the program. In a multi-decade effort it is vital to explore the acquisition strategy carefully before embarking on a course of action. The purpose of this white paper is to set out the issues that help identify the key criteria for the creation of strategies and policies that help to define the required relationships, contractual mechanisms and incentives that will achieve the objectives identified as keys to success in the future Performance Based Environment (PBE).

The emerging paradigm that is present today represents an integrated performance based environment (PBE) for both acquisition and sustainment. This is an appropriate paradigm shift given that, over the life cycle of most systems, about 30% of all dollars spent are used to acquire the system, while the remaining 70% of all dollars are used for maintenance. Ultimately the challenge for the program manager, is to structure the correct relationships with contractors by incorporation of the appropriate contractual mechanisms and incentives to gain the most efficient and effective performance of the system for its entire life.

Known as life-cycle support the objective of improved acquisition is to concurrently incorporate sustainment decisions in the first phases of the acquisition cycle. By incorporating sustainment concerns at the earliest phases of development, the product manager can incorporate the appropriate level of support required for long term deployment. This means that many of the objectives such as modernization, obsolescence, technology insertion, spiral development, and simplification can be achieved.

Changing current business practices to be more like commercial entities presents a host of new issues. Specifically, additional challenges come from the development of new processes, contractual incentives and relationships that flourish in PBE. To meet these challenges the government and its contractors must agree on the best approaches that deliver the highest value for all parties. In addition, depending on the stability of the technology, the viability of real alternatives and the amount of uncertainty present, the contractual mechanisms and incentives are likely to vary. Thus, the major issues that confront managers that engage in these high technology projects is what types of incentives to use, when to implement them and how to remove uncertainty from the process.

Lessons from Organizational Theory[1]

Relationships between organizations are created on the basis of transactions. The term *governance* is broadly defined as a "mode of organizing transactions" (Williamson and Ouchi 1981). Much of recent research has been dedicated on understanding the interorganizational governance structure that companies adopt in their relational and marketing programs. According to the topology outlined by Heide (1994), interfirm governance can be segmented into three different forms: discrete, unilateral (hybrid) and bilateral (relational). Any relationship between organizations that do business together can be placed on the resulting continuum created by this basic topology. The following are the three forms along with their description:

- Discrete exchanges reflect market governance, meaning the trade conforms to basic economic principles of transaction exchange. "A one-time purchase of unbranded gasoline out-of-town at an independent station paid for with cash" (Dwyer, Schurr, and Oh 1987) would exemplify this type of governance. Although opportunistic behavior is at a high level in this form of governance, competition is inherently elevated.

- Hybrid governance structures include an infinite amount of variations and takes characteristics from both the discrete and the bilateral structures. Most organizations are under this governance structure, which include, but are not limited to affiliations, franchises, and joint ventures. These unilateral structures display a level of hierarchical command that is embedded within contracts.

- Bilateral governance structures (relational governance structures) are controlled by mechanisms both economical and sociological in nature. Poppo and Zenger (2002) note that "relational governance is associated with trust and trust improves the performance of inter organizational exchanges," suggesting a do "what's good for the team" attitude. Contrasting the discrete and hybrid governance forms discussed above, incentive systems, monitoring mechanisms, and termination clauses are absent in relational/bilateral exchange due to a complete understanding based on the mutuality of interest.

Flexibility (adaptation to unforeseeable events), solidarity (commitment to joint action), and mutuality are a few of the dependant variables that can be quantified with established research methods. These normative structures gauge the level of opportunism and are utilized to categorize the type of governance and the strength of the relationship. The issues of trust, loyalty, and opportunism play a critical role, as they further dictate where the organization belongs on the governance continuum. Beyond the obvious time and cost expenses, several maintenance initiatives are required to sustain a relationship. Certain mechanisms need to be enacted, such as the specification of roles, ability to adjust to situations, a monitoring system, an incentive system, and an enforcement system.

Lessons from DoD Efforts at Acquisition Reform[2]

Large multi-year cost-plus contracts are almost a thing of the past. The new environment of performance based contracts and milestone development protects the budget from being devoured by program growth but at the same time has introduced a high level of uncertainty into

[1] This section is largely excerpted from an unpublished manuscript by Berkowitz and Singh, the University of Alabama in Huntsville.
[2] This section has been excerpted from Rogers and Birmingham, 2004, Defense Acquisition Review Journal.

the program management side of acquisition. This has in turn affected the relationship between the DoD and industry exacerbating the already weak industrial base. It is also likely that continued budgetary constraints because of the demands of homeland security will make cost efficiency and cost-effectiveness essential to all military spending plans.

The concept of evolutionary acquisition is not new. For the past ten plus years, DoD program managers have modified their fielded systems with technology insertions, usually benefiting from commercial innovations. Over the last ten years the palying field has shifted from a DoD centric technology base...where much of the war fighting technology was developed for and within the DoD military-industrial base to commercial centric technology development. DoD programs have become hostages to the velocity and pace of commercial standards and demands. To survive, program managers had to shift their development and technology insertion strategies from leader to follower...often becoming the tail end of scalable products. Although this strategy has helped to slow down the pace of obsolescence, little has been done to address the program and planning processes to pay for these efforts.

The Apache FLIR technology lagged behind the commercial standard not because of availability of technology but because funding was not planned well in advance of the technological maturity and test complete dates. Comanche has changed its mission processing technology three times since 1991, not because additional processing capability was required but because INTEL chose not to manufacture a Comanche-only P133/233 and transfer controller chips. To plan for a smooth transition to production plan, the Comanche program manager was challenged to hold a development base line configuration through the first few lots of production in order to keep development on schedule and keep costs down. Without a special, congressionally approved re-programming action, the program would have been forced to change processing architectures in mid development...further delaying the fielding of the system.

Configuration management of DoD systems, particularly non-COTS systems present another unique challenge for DoD program managers. Since DoD systems are not fielded like Ford automobiles, multiple configurations of the same system is a given. Comanche will field 650[3] aircraft starting in 2008 and complete fielding in 2020. Using the last ten years as a model, it is likely that there will be at least 4 different Comanche configurations in our Army when the last lot of aircraft is delivered. Planning for technology upgrades and phased recapitalization lacks support across the DoD budget leadership. DoD will not plan for funding against notional requirement changes and obsolescence when current operations and fiscal shortfalls to current systems exist. The consequence has been the need for greater O&S dollars to support multiple systems....and this trend does not seem likely to change. The push for spiral development contributes to this growing demand for support dollars in operational years. This is an indication of what may happen at NASA in a twenty year development program for a future Crew Exploration Vehicle. Spiral development and performance based contracts can lead to massive contradictions. The Comanche program was terminated in February 2004 after more than 20 years in development. Program structure risk can lead to termination as much as technology risk.

[3] The Army requirement was for 819 but the Defense Acquisition Board only approved 650. Later the Comanche Program was cancelled and it is now in the process of being dismantled.

Lessons from the Space Shuttle Contract[4]

On October 6, 1996, NASA awarded the Space Flight Operations Contract (SFOC) to United Space Alliance (USA), a joint venture between Boeing and Lockheed-Martin. The SFOC involved a major consolidation of Space Shuttle operations under a single contract. The SFOC also represented a major shift in NASA policy, as stated in the following passages from the contract introduction:

> As the Space Shuttle Program (SSP) and International Space Station Program (ISSP) evolve, NASA continues to seek ways to improve performance under the overarching goals of flying safely, maintaining mission success and schedule while achieving cost savings. The next step in this evolutionary process is the consolidation of major operations efforts under a single contract, the Space Flight Operations Contract (SFOC)… To meet Federal downsizing goals, NASA has designed policies to minimize civil servant participation in non-Research and Development areas. Currently, development work remains on several Space Shuttle flight elements such as Super Light Weight Tank (SLWT)… In contrast, the relatively mature elements and launch operation functions at KSC and flight operations functions at JSC, while critically important to NASA's own responsibility in the conduct of both launch and flight operations as well as development of ISS operations capability, are candidates for consolidation and reduced civil servant involvement.

With these provision, NASA chose to reduce its civil service demands, putting much more of the shuttle program's stewardship in the hands of a prime contractor. NASA would retain control of critical Space Shuttle decisions, but the bulk of the work would be transferred to the control of a prime contract. The SFOC was awarded at a time when the federal government was moving toward performance based contracting (PBC). PBC emphasizes that:

> All aspects of an acquisition be structured around the purpose of the work to be performed as opposed to the manner in which the work is to be performed…It is designed to ensure that contractors are given freedom to determine how to meet the government's performance objectives.(OMB, 1998)

NASA followed this path with the SFOC contract as stated in the introduction to the contract:

> SFOC is written to reflect performance based requirements which emphasize results and minimize 'how to' performance descriptions. The Contractor has responsibility for total performance, including accountability for all subcontracted activities. The performance-based requirements, which reflect NASA's minimum needs, provide exceptional flexibility to the Contractor.

There are some important lessons from this contract that future programs should be aware of when crafting an acquisition strategy. These are the direct lessons of the SSP SFOC contract:

- The SFOC, by design, does not include an explicit plan for the management of shuttle knowledge since knowledge management may be considered a process left up to the contractor.

[4] This section is largely excerpted from a white paper produced for Ames Research Center by David Marx of Outcome Engineering.

- The short-term nature of SFOC does not promote knowledge retention beyond the life of the current contract since that knowledge will be of no use if the contract is not won, and worse the knowledge will only help a competitor challenge the incumbent.
- The nature of short-term competitive contracting, such as the SFOC, does not promote knowledge sharing across competitors and even does not promote sharing of knowledge within the contractor hierarchy (from prime to subs and sub to sub).
- NASA must reconsider its contracting models to reposition NASA as the custodian of shuttle program knowledge since that is the national treasure it is entrusted to manage.

Lessons from Product Development[5]

Product development models are widely used in industry to monitor and manage technology investments. To effectively allocate resources an effort must take place to define and map the different types of development projects. One example model (figure 1) shows products on the map based on the need for process change or product change. The greater the change in product or process the greater the resources required to implement the plan. In the case of spiral development many of the process and products are unknown at the time of inception. In fact, the development of the completed product will be unknown. Thus, the development process will follow stages and will have many different technologies in various stages of development simultaneously.

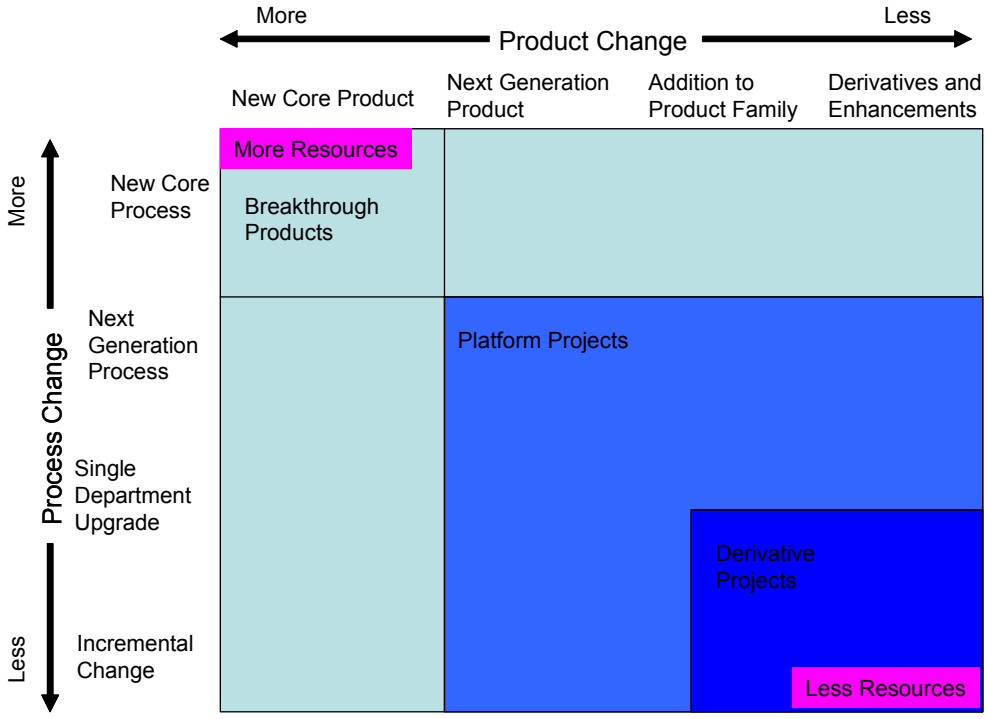

Figure 1 Model of Product Development Resource Allocation Determination

[5] This model was provided by Dr. Berkowitz at the University of Alabama in Huntsville.

This model is helpful if product development project are broken down into three types. The three types of projects include Breakthrough projects which require significant changes to existing products or processes and greater resources; Platform projects which require many process and product changes with little or no changes to materials technology or product technology and; Derivative projects that result in cost reduced versions or add-ons to existing technology and products and the least resources. Clearly, the implication is that each of these projects and the resulting products to be produced should be contracted for differently. Each project type will require different incentives, resources, and contractors all with specified outcomes. The figure shows these relationships. Spiral development means that as new products and process are developed they move from the upper left hand corner to the lower right. All of the expected contract mechanisms apply to phase of development. For spiral development to work there must be planning to discriminate between product development stages and the flexibility to manage the contractual relationship to appropriately match the resource needs. Government efforts at spiral development have sometimes overlooked this required tuning in the performance based environment.

Applying Spiral Development and PBC at NASA

Spiral development offers the possibility of avoiding technology obsolescence by continually allowing technology insertion into long-term programs. As noted above, to achieve this benefit, the program systems integrator must have the flexibility contractually to make the block changes that allow for appropriate technology insertions. Long term, highly specified performance based contracts may be detrimental to the spiral development concept because they disincentivize prime contractors from collecting and managing project knowledge and from sharing it with potentially competitive partners. This suggest that NASA must reconsider the concept of contracting out the lead integration role and instead retain that role, the risks associated with it and the opportunity to leverage project knowledge into the spiral development process.

The lessons also demonstrate that the spiral development process demands a degree of flexibility in type of contract not available in typical PBC instruments. Spiral development must be able to migrate products or technologies from development into testing and operations with appropriate contract vehicle modifications. PBC cannot cover a development effort from concept development to production because the contractor will not be motivated to change course once a design direction is taken. This contradicts the concept of spiral development. To benefit from both spiral development and PBC, NASA must play the role of systems integrator and be able to make trade offs between invested designs and new technology possibilities on a broad scope.

Finally, spiral development and PBC have implication for NASA's effort at technology spin-off. Frozen development pipelines as a result of PBC may contribute to greater lags in technology transfer as contractors are interested in extracting a return as long as possible. A spiral development model can change the playing field by keeping the commercial viability of any one product subject to further developments that may be inserted at any time. Thus the contractor would be motivated to move to commercial as soon as possible because of the threat of obsolescence as in the competitive commercial world. This would in turn drive technology development which itself fuels the spiral development process.

Summary

The success of all the NASA programs is predicated by the strength of the relationships with the contractors. These relationships are bound by legal contracts that clarify the specific terms of the deal. For example, opportunist behavior, is discussed in the 1994 report entitled "NASA contract Management: Improving the Use of DCAA's Auditing Services." In it, the Director of the Defense Management and NASA Issues states that NASA "need[s] for an enforcement mechanism to deter contractors from claiming unallowable costs". This display of opportunism by the contractors is still a major concern for the organization. Furthermore, in another GAO release in 2003, there was a high level of "undefinitized contract actions" in regards to contracts dealing with the International Space Station. These actions, which were unauthorized changes to contracts, were stated as resulting in cost overruns and cost growth to the program.

This paper draws attention to NASA's problems in dealing with contract management and some key lessons learned from the contracting world. How can Code T at the beginning of its charter, plan to avoid the mistakes made in previous acquisition strategies? It appears that NASA has accepted unintended consequences by adopting contracting mechanisms without fully understanding the marketplace, industrial policy and competitive game structure. Code T should use the tools available to industry to craft an acquisition strategy that aligns government, industrial and labor concerns over the long term. This requires a higher fidelity of contracting in order to reap the benefits of spiral development and performance based contracting. Creating bilateral relationships between NASA and its contractors is essential to safeguarding scarce resources and ensuring their efficient and effective use on behalf of the American taxpayer.

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